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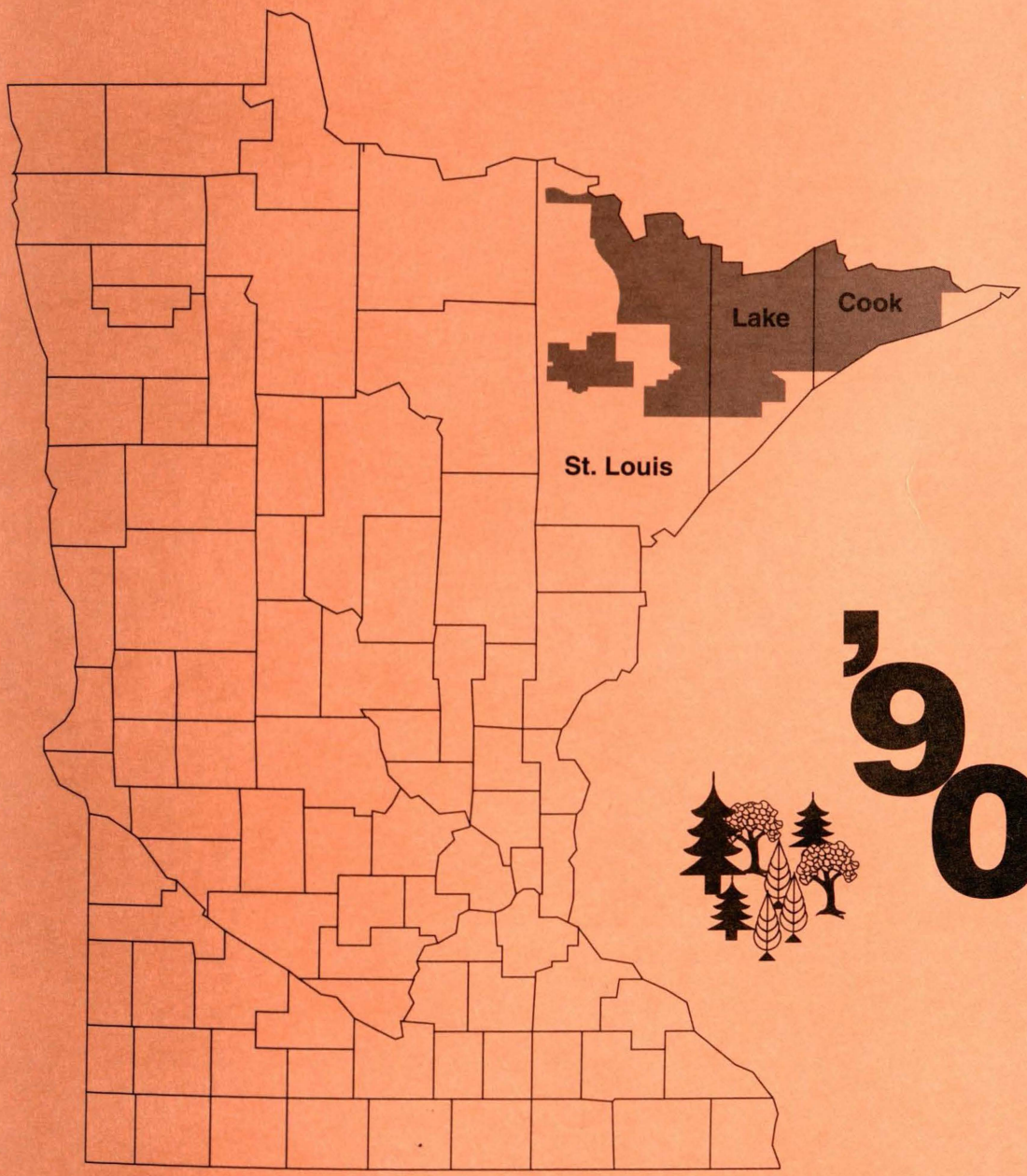
The Timber Resource of the Superior National Forest

Neal P. Kingsley and John Ramquist



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Note: *Data from new forest inventories are often compared with data from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have occurred since 1980. Because some of the changes will make it inappropriate to directly compare the 1990 data with those published for 1980, data from the 1980 inventory have been reprocessed using the 1990 procedures. Please refer to the section labeled "Comparing Minnesota's Fifth Inventory With the Fourth Inventory" for more details.*

On February 13, 1909, President Theodore Roosevelt signed Proclamation Number 848, designating the Superior National Forest. This act was the culmination of a long effort by Christopher C. Andrews, the first Chief Fire Warden and later Forestry Commissioner of Minnesota, and a group of Twin Cities citizens to preserve various segments of Minnesota's forests from extensive logging and the fires that often followed. From 1902 to 1908 the General Land Office withdrew 1.2 million acres of public domain lands from homesteading. Then in 1912, 380,000 acres was purchased under the Weeks Act to round out the Superior National Forest.

The Duluth Herald of February 22, 1909, with remarkable vision, printed the following opinion of President Roosevelt's proclamation: "...The new reserve is quite likely to be a permanent forest reserve, and by reason of its size and location, it will become in time one of the most important in the country. The setting aside of this forest reserve is also hailed with satisfaction by all who are interested in the movement to establish an international game preserve in Minnesota, and Ontario, Canada. Such a preserve will attract thousands of sportsmen to Minnesota and the State will benefit from the resources."

The Superior National Forest and the adjacent Quetico Provincial Park in Canada contain some of the most beautiful land in the Great Lakes region. Dotted with hundreds of lakes surrounded by majestic forests, the area is a magnet for campers, canoeists, hunters, backpackers, and fishermen. To preserve the pristine nature of some of the forest's most attractive areas, the Superior Roadless Primitive Area was established in 1938. It was essentially this area that was to become the Boundary Waters Canoe Area Wilderness (BWCAW). This area of more than 1 million acres of forest and water is administered by the Superior National Forest and by the State of Minnesota. The BWCAW is an area of breathtaking natural beauty that, except for a few motor routes, is open only to primitive modes of travel. In 1990, the BWCA provided more than 1.2 million visitor days of wilderness recreation. The forest also provided about 2.4 million recreation visitor days on its lands outside the wilderness.

Although recreation, particularly primitive recreation, is a major product of the Superior, it is far from the only product. The forest

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contains 43 distinct watersheds, which provide quality water for fish and habitat for other aquatic species. This, in turn, provides safe and abundant prey for bald eagles and osprey. The Superior also plays a major role in maintaining wildlife habitat. It hosts about 175 species of birds ranging in size from the hummingbird to the bald eagle. Almost 50 species of mammals inhabit the forest, from the tiny shrew to the majestic moose. The forest is also home to a large portion of the only remaining timber wolves in the lower 48 States.

In addition to recreation, watershed protection, and wildlife habitat, the Superior National Forest annually produces wood for Minnesota's forest-based industries. This report is about the timber producing role of this multiple-use national forest.

Forest Area

The area of forestland in the Superior National Forest totals nearly 2.1 million acres. Although forestland has increased only 5 percent since 1980, the portion available for timber harvesting has risen 20 percent to more than 1.2 million acres. Much of this increase can be attributed to a reclassification of lands from unproductive forestland. The first of these reclassifications occurred when lands previously classified as unproductive were found to be marginally productive when remeasured. The second resulted when the final boundaries of the Boundary Waters Canoe Area Wilderness were established. Before that, a much larger area was classed as productive reserved because of the possibility that it might be included in the final area of the wilderness. In 1980, 858 thousand acres of forestland within the forest were classified as productive reserved. By 1990, the area of productive reserved forestland had dropped to 761 thousand acres. Nearly all of this land is within the wilderness.

The aspen forest type dominates the Superior (fig. 1). More than 408 thousand acres, nearly one-third of the forest's timber, is in this type. Black spruce is the second most important type with 211 thousand acres. Black spruce replaced balsam fir as the Superior's second most abundant species primarily because many areas of black spruce swampland were found to be marginally productive in this inventory. The acreage of balsam fir remained essentially unchanged at 168 thousand acres. The area of paper birch, another important type on the Superior, rose 18 percent to nearly 133 thousand acres. Timber markets for birch are poor in Minnesota, particularly in northeastern Minnesota. For this reason, almost half of the gross volume of birch grown each year is lost to natural mortality. Only a small fraction is used for products. Thus, while the area and total volume of the birch type is increasing, dead and dying birches are evident throughout the region. The area of white pine declined between inventories by nearly 50 percent to 11,300 acres. Much of this decline can be attributed to the natural succession of forest types. Left undisturbed by cutting, fire, disease, insects, or wind storm, shade tolerant species like red or sugar maple can persist for years beneath intolerant species like white pine. As the pines mature and eventually die or are harvested, the red maples take over dominance of the stands. This phenomenon is not unique to this region, but has been occurring throughout the East in the absence of fire and other major stand disturbances. The area of the red maple on the Superior more than doubled between 1980 and 1990. Although these stands evolve into hardwood stands, they usually contain a significant white pine component. This is attested to by the fact that the volume of white pine growing stock on the Superior actually increased from 1980 to 1990, while the area in the type decreased. The area of red pine, another major type on the Superior, showed a 9.5-percent increase to 60,600 acres.

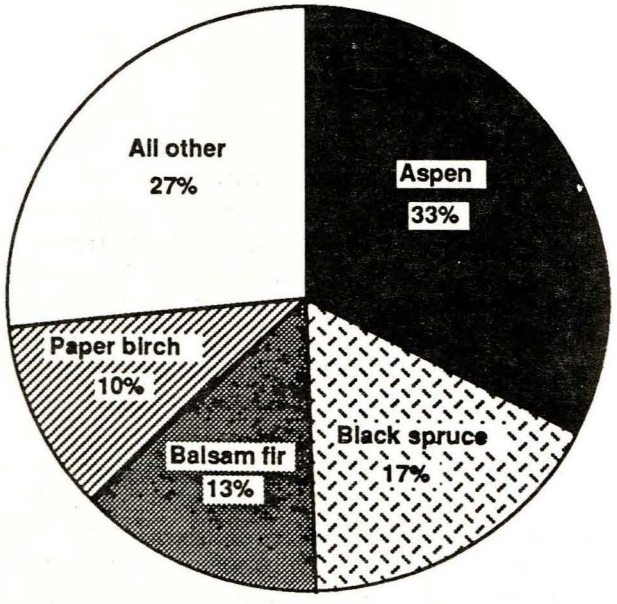

Figure 1.—*Area by major forest type.*

The timberland on the Superior is maturing (fig. 2). The area of sawtimber-size stands rose 36 percent to 382 thousand acres in 1990. However, the overall productivity of the Superior is moderately poor. More than 65 percent of the timberland on the forest is not capable of growing more than 50 cubic feet of usable wood per acre per year.

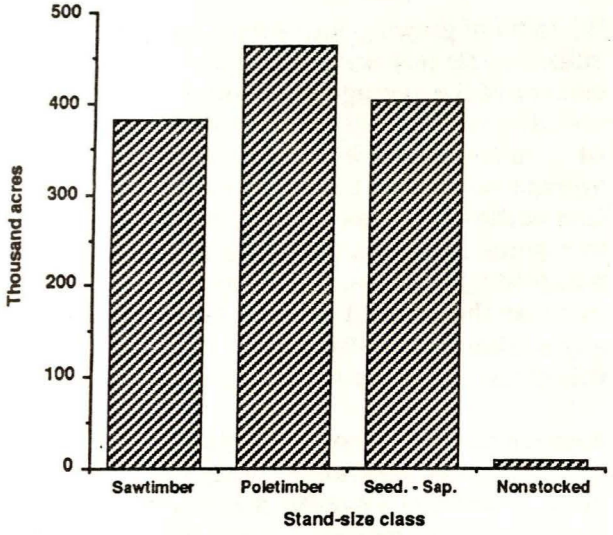

Figure 2.—*Area by stand-size class.*

Timber Volume

In 1990, the volume of growing stock on the Superior stood at nearly 1.4 billion cubic feet, a 37 percent increase from 1980 (fig. 3). Nearly all species shared in this increase. Red maple showed the greatest gain—up 250 percent to 25 million cubic feet in 1990. Jack pine showed the largest gain among the softwoods, a gain of more than 120 percent, to nearly 87 million cubic feet. White pine volume increased 9.8 percent to 54.1 million cubic feet. Although the total volume of white pine increased, the proportion of large trees, those more than 14 inches d.b.h., declined from 24.7 percent to 19.7 percent of the total between inventories. However, these trees account for 76 percent of the white pine sawtimber volume. Red pine was the only major species to decline in volume between inventories—from 94.6 million cubic feet in 1980 to 77.9 in 1990. Aspen, the most important species on the Superior from a commercial point of view, had 356 million cubic feet in 1990, up nearly 44 percent from 1980.

The change in stand-size classes is an indication of what has been happening to timber volumes on the Superior. The volume in sawtimber-size trees, softwoods over 9 inches d.b.h. and hardwoods 11 inches d.b.h. or larger, has increased more than 50 percent since 1980. Sawtimber-size trees now account for 650 million cubic feet, 48 percent of the timber volume on the forest. Sawtimber trees contain 3.2 billion board feet of lumber.[1] The volume of sawtimber in all major species increased significantly; only red pine showed a modest decline. The volume in aspen sawtimber-size trees was 857 million board feet in 1990, up 69 percent from the 1980 estimate.

Timber Growth and Removals

As mentioned earlier, the capacity of the Superior to produce timber is relatively low. This reflects the number of excessively wet

[1] *International 1/4-inch rule.*

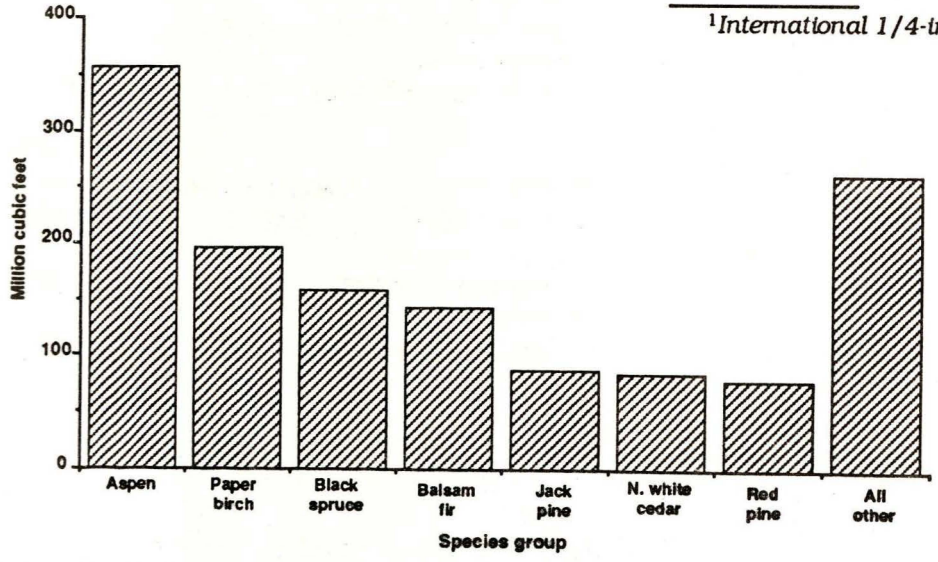

Figure 3.—*Volume of growing stock by major species group.*

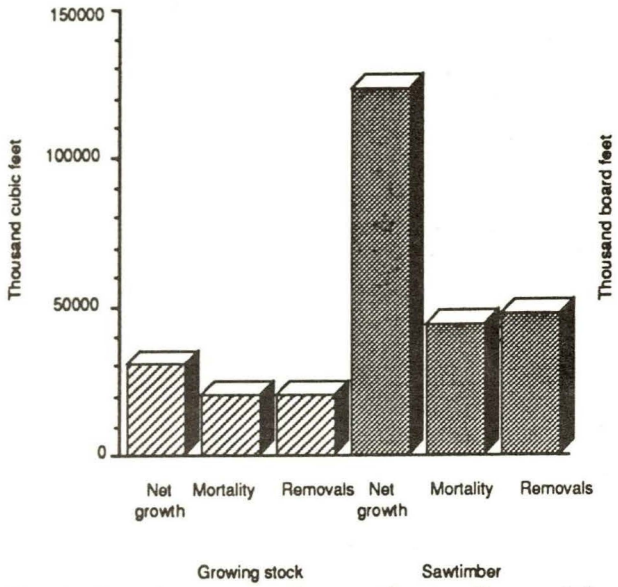

Figure 4.—*Average net annual growth, mortality, and removals of growing stock and sawtimber, 1980-1990.*

sites in lowland areas and the number of upland sites with thin soils in this region. From 1980 to 1990, net annual growth averaged nearly 30.8 million cubic feet per year or about 27 cubic feet per acre (fig. 4). This is approximately 2.6 percent of the average inventory of 1.2 billion cubic feet during the period. But, growth on the Superior, while low, is somewhat higher than the average for this region reflecting the more active forest management on this forest. Net annual growth of sawtimber averaged 123.2 million board feet per year between 1977 and 1989—about 4.6 percent of the sawtimber inventory.

Mortality of growing-stock trees averaged 20.3 million cubic feet per year—approximately 1.7 percent of the average inventory between inventories. Mortality of sawtimber averaged 44.1 million board feet, also 1.7 percent of the average sawtimber inventory for the period. One of the objectives of forest management is to minimize the loss of timber to mortality. By minimizing this loss, the Superior can actually increase the amount of wood harvested annually while still maintaining or increasing the volume in the inventory.

Average annual removals of growing stock nearly equaled mortality during the1980-1990 period. Removals averaged 20.1 million cubic feet. Likewise, removals of sawtimber slightly exceeded mortality at 47.9 million board feet between inventories.

Appendix

Accuracy of the Survey

Forest Inventory and Analysis information is based on a sampling procedure designed to provide reliable statistics at the State and Survey Unit levels. Consequently, the reported figures are estimates only. A measure of reliability of these figures is given by sampling errors. These sampling errors mean that the chances are two out of three that if a 100-percent inventory had been taken, using the same methods, the results would have been within the limits indicated.

For example, the estimated growing-stock volume in the Superior National Forest in 1990, 1,358.1 million cubic feet, has a sampling error of ±2.42 percent (±32.9 million cubic feet). The growing-stock volume from a 100-percent inventory would be expected to fall between 1,325.2 and 1,391.0 million cubic feet (1,358.1 ± 32.9, there being a one in three chance that this is not the case).

The following tabulation shows the sampling errors for the Superior National Forest Inventory:

Item	Unit totals	Sampling error
Growing stock	(Million cubic feet)	(Percent)
Volume (1990)	1,358.1	2.42
Average annual growth (1980-1989)	30.8	4.18
Average annual removals (1980-1989)	20.1	32.39
Sawtimber	(Million board feet)	
Volume (1990)	3,190.9	3.78
Average annual growth (1980-1989)	123.2	4.86
Average annual removals (1980-1989)	47.9	45.73
Timberland area (1990)	(Thousand acres) 1,253.9	1.23

As survey data are broken down into segments smaller than Survey Unit totals, the sampling

error increases. For example, the sampling error for timberland area in a particular county is higher than that for total timberland area in the Unit. This tabulation shows the sampling errors for Unit totals. To estimate sampling error for data smaller than Unit totals, use the following formula:

$$\text{Error} = \frac{(SE)\ \sqrt{(\text{National Forest total area or volume})}}{\sqrt{(\text{Volume or area smaller than National Forest total})}}$$

where:

E = sampling error in percent
SE = National Forest total error for area or volume

For example, to compute the error on the volume of quaking aspen in the Forest, proceed as follows:

The total volume of quaking aspen in the Forest from table 8 = 356.2 million cubic feet.

The total volume of all growing stock in the Forest from table 8 = 1,358.1 million cubic feet.

The total error for volume of all growing stock = ±2.42 percent.

Using the above formula:

$$\text{Error} = \frac{(.0242)\ \sqrt{1{,}358{,}100}}{\sqrt{356{,}200}}$$

$$= \pm 4.73 \text{ percent}$$

SURVEY PROCEDURES

The 1990 Minnesota survey used a growth model-enhanced, two-phase sample design. Using this sampling scheme and associated estimators is similar to sampling with partial replacement (SPR), in that a set of randomly located plots is available for remeasurement and a random set of new plots is established and measured. A significant feature of the new Minnesota design is stratification for disturbance on the old sample and use of a growth model to improve regression estimates made on old undisturbed forest plots (fig. 5 on next page). Detailed descriptions of the sampling and estimation procedures are presented by Hansen (1990)[2]. The growth model used in the Minnesota survey design was the Lake States Stand and Tree Evaluation and Modeling System (STEMS)[3].

These were the major steps in the new survey design:

1. Aerial photography (Phase 1)

In this phase two sets of random points were located on current aerial photography. The first is a set of new photo plots, and the second is a set of reestablished ground plots from the 1980 inventory. Photos were 1:58,000 scale color infrared National High Altitude Photography (NHAP) prints purchased by the Minnesota Department of Natural Resources (MDNR) from the U.S. Geological Survey. In addition, MDNR provided 35 mm true color prints at a scale of 1:15,840 of all of the 1980 ground plot locations. These 35 mm prints were used in addition to the NHAP prints to aid in detecting disturbance on the 1980 ground plots. The year of photography for each county in the Unit is shown below.

	Date	
County	NHAP	35 mm
Cook	1984	1986-1987
Lake	1981-1984	1986-1987
St. Louis	1981	1986-1987

The locations of the plots used in the 1980 inventory were transferred to these new photographs. The photographs were then assembled into township mosaics, and a systematic grid of 121 one-acre photo plots (each plot representing approximately 190.4 acres) was overlaid on each township mosaic. Each of these photo plots was examined by aerial photogrammetrists and classified stereoscopi-

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[2] *Hansen, Mark H. 1990. A comprehensive sampling system for forest inventory based on an individual tree growth model. St. Paul, MN: University of Minnesota, College of Natural Resources. 256 p. Ph.D. dissertation.*

[3] *Belcher, David W.; Holdaway, Margaret R.; Brand, Gary G. 1982. A description of STEMS—the Stand and Tree Evaluation and Modeling System. Gen. Tech. Rep. NC-79. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 18 p.*

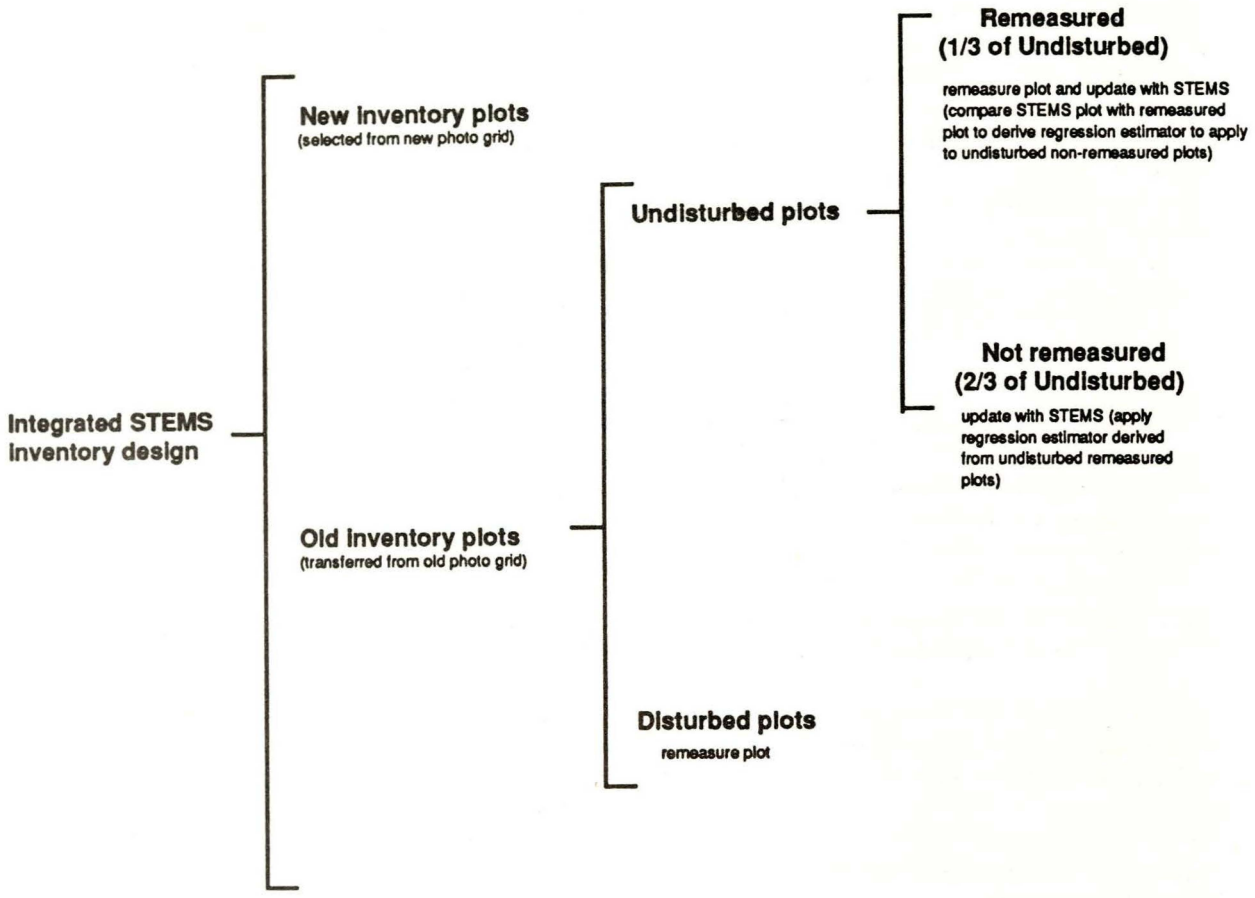
Integrated STEMS inventory design
New inventory plots
(selected from new photo grid)
Old inventory plots
(transferred from old photo grid)
Undisturbed plots
Remeasured
(1/3 of Undisturbed)
remeasure plot and update with STEMS (compare STEMS plot with remeasured plot to derive regression estimator to apply to undisturbed non-remeasured plots)
Not remeasured
(2/3 of Undisturbed)
update with STEMS (apply regression estimator derived from undisturbed remeasured plots)
Disturbed plots
remeasure plot

Figure 5.— *Overview of the Minnesota sample design.*

cally based on land use. If trees were present, forest type and stand size-density class were recorded. All the 1980 ground plot locations were also examined for disturbance (logging, fire, catastrophic mortality, etc.) with the aid of the 35 mm photography. After this examination, all the old *"disturbed"* sample locations, a one-third sample of the old *"undisturbed"* sample locations, and a sample of the new photo plots were sent to the field for survey crews to verify the photo classification and to take further measurements. In all, 11,012 new photo plots and 234 ground plots from the 1980 inventory were examined for the Superior National Forest and were classified as shown in the following tabulation:

Photo land class	Photo plots
Timberland	6,039
Reserved timberland	3,970
Other forest land	173
Questionable	256
Nonforest with trees	77
Nonforest without trees	667
Water	64
All classes	11,246

2. Plot measurements (Phase 2)

On plots classified as timberland, wooded pasture, or windbreak (at least 120 feet wide), a ground plot was established, remeasured, or modeled. Old plots that could not be relocated by field crews were replaced with a new plot at the approximate location of the old one. Each ground plot consists of a 10-point cluster covering approximately 1 acre. At each point, trees 5.0 inches or more in d.b.h. were sampled on a 37.5 Basal Area Factor (BAF) variable-radius plot, and trees less than 5.0 inches d.b.h. were sampled on a 1/300-acre fixed-radius plot. The measurement procedure for the new and old sample locations was as follows:

a. New inventory plots

A random sample of the new photo plots was selected for field measurement. Ground plots were established, and measures of current classification such as land use, forest type, and ownership as well as the size and condition of all trees on the plot were recorded.

These plots were monumented for future remeasurement.

b. Old inventory plots

These are the plots that were established, monumented, and measured as part of the 1980 field inventory. The procedures for these old plots were different from those for the new plots. Old plots were classed as "*undisturbed*" or "*disturbed*" in the aerial photo phase of the sampling process. All disturbed plots and a one-third sample of the undisturbed plots were remeasured to obtain estimates of current condition and changes since the last inventory. All trees measured on these plots in 1980 were remeasured or otherwise accounted for, and all new trees were identified and measured.

All sample plots that were forested at the time of the 1980 inventory and that had been determined to be undisturbed (no evidence of conversion to another land use) were projected to the current time using STEMS. This procedure gives projected estimates of current volume and growth for these undisturbed plots. The comparison of the projected and observed values on the one-third sample of the undisturbed forest plots that were remeasured provided local calibration data to adjust the projected values of the undisturbed plots that were not remeasured. The adjustment procedure is a modified version of the method described by Smith[4].

The old sample undisturbed plots that had not been forested in1980 were also field checked at the one-third rate. Any changes in land use to forest detected on these plots were used to adjust the two-thirds sample of the plots not checked. The field check of these points on the Superior indicated that no adjustment was necessary.

The undisturbed plots that were not remeasured play a crucial role in the new survey design. These plots, after careful comparison of past and current aerial photography, were determined to be undisturbed and had conditions that could be simulated by STEMS. The STEMS growth model was used to "grow" the old plot and tree data to produce an estimate of current data. Thus, these plots were treated as ground plots, even though they were never visited. The plot record for each modeled plot was sent to the field for verification of current ownership information.

All old plots classified as disturbed were sent to the field for remeasurement to assess and verify changes since the last inventory. Disturbance refers to any change on a plot that can be detected on aerial photos and that the STEMS growth processor cannot predict, such as catastrophic mortality, cutting, presence of seedling stands, and land use change.

The estimation procedure for computing statistics from this sampling design was more complicated than the simple two-phase estimation procedure used in the past. In fact, this procedure yielded two independent samples, one coming from the new photo points and the other from the old photo points that were remeasured or modeled. The following tabulation summarizes the distribution of all ground plots for the new inventory design by type of plot:

Ground land use class	Old plots remeasured	Old plots updated	New plots	Total plots
Timberland	212	12	617	841
Reserved forest land	2	1	422	425
Other forest land	1	—	11	12
Nonforest with trees	1	—	4	5
Nonforest without trees	2	1	29	32
Water	—	2	7	9
Total	218	16	1,090	1,324

[4] *Smith, W. Brad. 1983. Adjusting the STEMS regional growth models to improve local predictions. Res. Note NC-297. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 5 p.*

3. Area estimates

The total area of National Forest land was supplied by the Forest staff. Subsequent area estimates were made using two-phase estimation methods. In this type of estimation, a preliminary estimate of area by land use is made from the aerial photographs (Phase 1) and corrected by the plot measurements (Phase 2). A complete description of this estimation method is presented by Loetsch and Haller, 1964.[5]

Area estimates within the Superior National Forest were determined in the same way as other lands but were verified by comparison with National Forest compartment examination records maintained by the Forest Timber Management Staff. This is an intensive area inventory system in which, over a period of years, each stand in the Forest is mapped on aerial photographs and then classified by ground visits.

4. Volume estimates

Estimates of volume per acre were made from the trees measured or modeled on the 10-point plots. Estimates of volume per acre were multiplied by the area estimates to obtain estimates of total volume. Net cubic foot volumes are based on a modification of the method presented by Hahn (1984)[6] for use in the Lake States. For the Minnesota inventory, the merchantable height equation presented was used in conjunction with Stone's equation to estimate gross volume. This estimate was then corrected by species for variation in bark and cull volume to yield an estimate of net volume.

The Forest Service reports all board foot volume in International 1/4-inch rule. In Minnesota, the Scribner log rule is commonly used. Scribner log rule conversion factors were derived from full tree measurements taken throughout the Lake States (Michigan, Wisconsin, and Minnesota) and an equation developed by Wiant and Castenaeda (1977)[7]. The factors (multipliers) used here to convert board foot International volumes to the Scribner rule are shown in the following tabulation:

D.B.H. (inches)	Scribner rule conversion factor	
	Softwoods	Hardwoods
9.0-10.9	0.7830	- -
11.0-12.9	.8287	0.8317
13.0-14.9	.8577	.8611
15.0-16.9	.8784	.8827
17.0-18.9	.8945	.8999
19.0-20.9	.9079	.9132
21.0-22.9	.9168	.9239
23.0-24.9	.9240	.9325
25.0-26.9	.9299	.9396
27.0-28.9	.9321	.9454
29.0+	.9357	.9544

5. Growth and mortality estimates

On remeasured plots, estimates of growth and mortality per acre come from the remeasured diameters of trees and from observation of trees that died between inventories. Growth reported is the average net annual growth between the two inventories (1980 and 1990) and is computed from data on remeasurement plots and modeled plots using methods presented by Van Deusen *et al.* (1986)[8]. Mortality is also average net annual for the remeasurement period. On new plots, where trees were not remeasured, estimates of growth and mortality were obtained by using STEMS to project the growth and mortality of trees for 1 year. Growth and mortality estimates for old undisturbed plots that were updated were derived in the same manner as those for remeasured plots. The STEMS growth model was adjusted by Survey Unit to meet local conditions using data from the undisturbed remeasurement plots. As with

[5] *Loetsch, F.; Haller, K.E. 1964. Forest inventory, volume I, statistics of forest inventory and information from aerial photographs. BLV Verlagsgesellschaft Munch Basle Vienna. 436 p.*

[6] *Hahn, Jerold T. 1984. Tree volume and biomass equations for the Lake States. Res. Pap. NC-250. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 10 p.*

[7] *Wiant, Harry V., Jr.; Castenaeda, Froylan. 1977. Mesavage and Girard's volume tables formulated. BLM4. Denver, CO: U.S. Department of Interior, Bureau of Land Management, Denver Service Center: 1-4 .*

[8] *Van Deusen, P.C.; Dell, T.R.; Thomas, C.E. 1986. Volume growth estimation from permanent horizontal points. Forest Science. 32: 415-422.*

volume, total growth and mortality estimates were obtained by multiplying the per acre estimates by area estimates. Current annual growth for 1989 was computed by using the adjusted STEMS model to grow all current inventory plots for 1 year.

6. Average annual removals estimates

Average annual growing-stock and sawtimber removals (1980 to 1989) were estimated from only the remeasured plots; new plots were not used to estimate removals. These estimates are obtained from trees measured in the last survey and cut or otherwise removed from the timberland base. Because remeasurement plots make up about one-half of the total ground plots, average annual removals estimates have greater sampling errors than volume and growth estimates.

COMPARING MINNESOTA'S FIFTH INVENTORY WITH THE FOURTH INVENTORY

The following paragraphs highlight some of the procedural changes since the last inventory to assist the reader in analyzing data from this report:

A new volume estimation procedure was developed for the Lake States (see Survey Procedures section), and this procedure was used to compute the 1980 volumes and to recompute the 1979 volume for growth calculations. Although the adjustment will differ by Survey Unit and species, the recomputed 1980 growing-stock and board foot volumes will generally be greater than those shown in the 1980 report.

Mortality figures published in the 1980 inventory report were based on field estimates of the number of trees that died in the 3 years before the inventory. Information gathered on remeasurement plots during the current inventory was used to adjust the 1979 mortality figures. This adjustment will also affect the estimate of net growth for the 1977 inventory.

Past surveys used only growing-stock trees to determine stand-size class. Current survey procedures require that stand-size class be determined on the basis of all live trees.. Therefore, direct comparisons of current inventory data to old inventory data by stand-size class may be misleading.

LOG GRADE

In Minnesota the butt log of every sawtimber sample tree was graded for quality on approximately one-third of the sample plots. The volume yield by log grade for species in this sample was used to distribute the volume of trees in the ungraded sample into log-grade classes by species group.

Logs were graded on the basis of external characteristics as indicators of quality. Hardwood species were graded according to "A guide to hardwood log grading" (1973)[9]. The best 12-foot section of the lowest 16-foot hardwood log, or the best 12-foot upper section if the butt log did not meet minimum log-grade standards, was graded as follows:

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[9] *Rast, Everette D.; Sonderman, David L.; Gammon, Glenn L. 1973. A guide to hardwood log grading. Gen. Tech. Rep. NE-1. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 31 p.*

Forest Service standard grades for hardwood factory saw logs

Grading Factors		Specifications							
		Log grade 1			Log grade 2				Log grade 3
Position in tree		Butts only	Butts & uppers		Butts & uppers				Butts & uppers
Scaling diameter, inches		13-15[1]	16-19	20+	11+[2]		12+		8+
Length without trim, feet			10+		10+	8-9	10-11	12+	8+
Required clear cuttings[3] of each of three best faces[4]	Min. length, feet	7	5	3	3	3	3	3	2
	Max. number		2	2	2	2	2	3	No limit
	Min. proportion of log length required in clear cutting	5/6	5/6	5/6	2/3	3/4	2/3	2/3	1/2
Maximum sweep & crook allowance	For logs with less than one-fourth of end in sound defects		15 percent			30 percent			50 percent
	For logs with more than one-fourth of end in sound defects		10 percent			20 percent			35 percent
Maximum scaling deduction			40 percent[5]			50 percent[6]			50 percent

1 *Ash and basswood butts can be 12 inches if they otherwise meet requirements for small #1's.*
2 *Ten-inch logs of all species can be #2 if they otherwise meet requirements for small #1's.*
3 *A clear cutting is a portion of a face, extending the width of the face, that is free of defects.*
4 *A face is one-fourth of the surface of the log as divided lengthwise.*
5 *Otherwise #1 logs with 41- to 60-percent deductions can be #2.*
6 *Otherwise #2 logs with 51- to 60-percent deductions can be #3.*

Forest Service standard specifications for hardwood construction logs (tie and timber logs)[1]

Position in tree	Butts and uppers
Min. diameter, small end	8 inches +
Min. length without trim	8 feet
Clear cuttings	No requirements
Sweep allowance	One-fourth of the diameter at the small end for each 8 feet of length.
Sound surface defects:	
Single knots	Any number, if no one knot has an average diameter above the callus in excess of one-third of the log diameter at point of occurrence.
Whorled knots	Any number, if the sum of knot diameters above the callus does not exceed one-third of the log diameter at point of occurrence.
Holes	Any number, provided none has a diameter over one-third of the log diameter at point of occurrence and none extends more than 3 inches into included timber[2].
Unsound surface defects :	Same requirements as for sound defects if they extend into included timber. No limit if they do not.

[1]*These specifications are minimum for the class. If, from a group of logs, factory logs are selected first, thus leaving only nonfactory logs from which to select construction logs, then the quality range of the construction logs so selected is limited, and the class may be considered a grade. If selection for construction logs is given first priority, it may be necessary to subdivide the class into grades.*

[2]*Included timber is always square, and dimension is judged from small end.*

LOG GRADES FOR EASTERN WHITE PINE

Log grade	Minimum size[1] Diameter (Inches)	Length (Feet)	Sweep or crook allowance (Percent)	Total cull allowance including sweep (Percent)	Maximum weevil injury (Number)	Allowable knot size (inches)[2] on three best faces or minimum clearness on four faces (Inches)
1	12 & 13	8-16	20	50	0	Four faces clear full length
	14+	10-16	20	50	0	Two faces clear full length, or four faces clear 50 percent length (6 feet min. length)[3]
2	6+	8-16	30	50	0	Sound knots l.e.[4] D/6 and les than 3 inches[5] Unsound knots: l.e. 1-1/2 inches and for: butt, logs l.e. upper logs l.e. D/10, or four fa clear 50 percent of length
3	6+	8-16	40	50	8-foot logs: 1 weevil	Sound knots l.e. D/3 and less than 5 inches
					10-foot+ logs: 2 weevils	Unsound knots l.e. D/6 and less than 2-1/2 inches
4	6+	8-16	50	50	No limit	No limit

[1] *Plus trim.*

[2] *Disregard all knots less than one-half inch in diameter in all grades.*

[3] *The sum of the diameter of sound knots plus twice the sum of the diameter of unsound knots (in inches) is less than or equal to half of the diameter of the log (inches).*

[4] *l.e. means less than or equal to.*

[5] *D means d.i.b. of log at location of knot.*

LOG GRADES FOR JACK PINE AND RED PINE

Grade 1: Logs with three or four clear faces.[1]

Grade 2: Logs with one or two clear faces.

Grade 3: Logs with no clear faces.

After the tentative log grade is established from above, the log will be degraded one grade for each of the following, except that no log can be degraded below grade 3. Net scale after deduction for defect must be at least 50 percent of the gross contents of the log.

1. *Sweep.* Degrade any tentative 1 or 2 log one grade if sweep amounts to 3 or more inches and equals or exceeds one-third of the diameter inside bark at small end.

2. *Heart rot.* Degrade any tentative 1 or 2 log one grade if conk, massed hyphae, or other evidence of advanced heart rot is found anywhere in it.

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[1]*A face is one-fourth of the circumference in width extending full length of the log. Clear faces are those free of: knots measuring more than one-half inch in diameter, overgrown knots of any size, and holes more than one-fourth inch in diameter. Faces may be rotated to obtain the maximum number of clear ones.*

LOG GRADES FOR ALL OTHER SOFTWOOD LOGS

Grade 1

1. Logs must be 16 inches in diameter or larger, 10 feet in length or longer, and with deduction for defect not over 30 percent of gross scale.

2. Logs must be at least 75 percent clear on each of three faces.

3. All knots outside clear cutting must be sound and not more than 2-1/2 inches in size.

Grade 2

1. Logs must be 12 inches in diameter or larger, 10 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross scale deducted for defect.

2. Logs must be at least 50 percent clear on each of three faces or 75 percent clear on two faces.

Grade 3

1. Logs must be 6 inches in diameter or larger, 8 feet in length or longer, and with a net scale after deduction for defect of at least 50 percent of the gross contents of the log.

Note: A) Diameters are diameter inside bark (d.i.b.) at small end of log.
B) Percent clear refers to percent clear in one continuous section.

METRIC EQUIVALENTS OF UNITS USED IN THIS REPORT

1 acre = 4,046.86 square meters or 0.405 hectare.
1,000 acres = 405 hectares.
1 cubic foot = 0.0283 cubic meter.
1 foot = 30.48 centimeters or 0.3048 meter.
1 inch = 25.4 millimeters, 2.54 centimeters, or 0.0254 meter.
1 pound = 0.454 kilograms.
1 ton = 0.907 metric tons.

TREE SPECIES GROUPS IN MINNESOTA[10]

SOFTWOODS
Eastern white pine ..... *Pinus strobus*
Red pine ..... *Pinus resinosa*
Jack pine ..... *Pinus banksiana*
White spruce ..... *Picea glauca*
Black spruce ..... *Picea mariana*
Balsam fir ..... *Abies balsamea*
Tamarack ..... *Larix laricina*
Northern white-cedar ..... *Thuja occidentalis*
Other softwoods:
Eastern redcedar ..... *Juniperus virginiana*
Scotch pine ..... *Pinus sylvestris*

HARDWOODS
Select white oak[11]
White oak ..... *Quercus alba*
Bur oak ..... *Quercus macrocarpa*
Select red oak[11]
Northern red oak ..... *Quercus rubra*
Other red oaks[11]
Northern pin oak ..... *Quercus ellipsoidalis*
Black oak ..... *Quercus velutina*
Hickory[11]
Shagbark hickory ..... *Carya ovata*
Bitternut hickory ..... *Carya cordiformis*
Hard maple[11]
Black maple ..... *Acer nigrum*
Sugar maple ..... *Acer saccharum*
Soft maple[12]
Red maple ..... *Acer rubrum*
Silver maple ..... *Acer saccharinum*
Ash[12]
Black ash ..... *Fraxinus nigra*
Green ash ..... *Fraxinus pennsylvanica*
Balsam poplar[12] ..... *Populus balsamifera*
Aspen[12]
Bigtooth aspen ..... *Populus grandidentata*
Quaking aspen ..... *Populus tremuloides*
Cottonwood[12] ..... *Populus deltoides*
Basswood[12] ..... *Tilia americana*
Black walnut[11] ..... *Juglans nigra*
Black cherry[12] ..... *Prunus serotina*
Butternut[12] ..... *Juglans cinerea*
Elm
American elm[11] ..... *Ulmus americana*
Slippery elm[12] ..... *Ulmus rubra*
Rock elm[11] ..... *Ulmus thomasii*
Hackberry[12] ..... *Celtis occidentalis*
Black willow[12] ..... *Salix nigra*
Other hardwoods
Boxelder[12] ..... *Acer negundo*
Black locust[11] ..... *Robinia pseudoacacia*
Red mulberry[12] ..... *Morus rubra*
Honeylocust[11] ..... *Gleditsia triacanthos*
Northern catalpa[11] ..... *Catalpa speciosa*
Noncommercial species
Eastern hophornbeam ..... *Ostrya virginiana*
Apple ..... *Malus* spp.
American hornbeam ..... *Carpinus caroliniana*
Wild plum ..... *Prunus* spp.
Hawthorn ..... *Crataegus* spp.

[10] *The common and scientific names are based on: Little, Elbert L. 1979. Checklist of native and naturalized trees of the United States. Agric. Handb. 541. Washington, DC: U.S. Department of Agriculture, Forest Service. 385 p.*

[11] *This species or species group is considered a hard hardwood, with an average specific gravity greater than or equal to 0.50.*

[12] *This species or species group is considered a soft hardwood, with an average specific gravity of less than 0.50.*

DEFINITION OF TERMS

Average annual removals from growing stock.—The average net growing-stock volume in growing-stock trees removed annually for forest products (including roundwood products and logging residues) and for other uses (see Other removals). Average annual removals of growing stock are reported for a period of several years (1980 to 1989 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Average annual removals from sawtimber.—The average net board foot sawtimber volume of live sawtimber trees removed annually for forest products (including roundwood products and other uses [see Other removals]). Average annual removals of sawtimber are reported for a period of several years (1980 to 1989 in this report) and are based on information obtained from remeasurement plots (see Survey Procedures in Appendix).

Commercial species.—Tree species presently or prospectively suitable for industrial wood products. (Note: Excludes species of typically small size, poor form, or inferior quality such as hophornbeam, osage-orange, and redbud.)

Commercial forest land.—(See Timberland).

Cord.—One standard cord is 128 cubic feet of stacked wood, including bark and air space. Cubic feet can be converted to standard cords by dividing by 79.

Cull.—Portions of a tree that are unusable for industrial wood products because of rot, missing or dead material, or other defect.

Diameter class.—A classification of trees based on diameter outside bark, measured at breast height (d.b.h.). Two-inch diameter classes are commonly used in Forest Inventory and Analysis, with the even inch the approximate midpoint for a class. For example, the 6-inch class includes trees 5.0 through 6.9 inches d.b.h.

Diameter at breast height (d.b.h.).—The outside bark diameter at 4.5 feet (1.37 m) above the forest floor on the uphill side of the tree. For determining breast height, the forest floor includes the duff layer that may be present, but does not include unincorporated woody debris that may rise above the ground line.

Forest land.—Land at least 16.7 percent stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use. (Note: Stocking is measured by comparing specified standards with basal area and/or number of trees, age or size, and spacing.) The minimum area for classification of forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must have a crown width of at least 120 feet to qualify as forest land. Unimproved roads and trails, streams, or other bodies of water or clearings in forest areas shall be classed as forest if less than 120 feet wide. (See Tree, Land, Timberland, Reserved forest land, Other forest land, Stocking, and Water.)

Forest type.—A classification of forest land based on the species forming a plurality of live tree stocking. Major forest types in the State are:

Jack pine.—Forests in which jack pine comprises a plurality of the stocking. (Common associates include eastern white pine, red pine, aspen, birch, and maple.)

Red pine.—Forests in which red pine comprises a plurality of the stocking. (Common associates include eastern white pine, jack pine, aspen, birch, and maple.)

White pine.—Forests in which eastern white pine comprises a plurality of the stocking. (Common associates include red pine, jack pine, aspen, birch, and maple.)

Balsam fir.—Forests in which balsam fir and white spruce comprise a plurality of the stocking with balsam fir the most common. (Common associates include aspen, maple, birch, northern white-cedar, and tamarack.)

White spruce.—Forests in which white spruce and balsam fir comprise a plurality of the stocking with white spruce the most common. (Common associates include aspen, maple, birch, northern white-cedar, and tamarack.)

Black spruce.—Forests in which swamp conifers comprise a plurality of the stocking with black spruce the most common. (Common associates include tamarack and northern white-cedar.)

Northern white-cedar.—Forests in which swamp conifers comprise a plurality of the stocking with northern white-cedar the most common. (Common associates include tamarack and black spruce.)

Tamarack.—Forests in which swamp conifers comprise a plurality of the stocking with tamarack the most common. (Common associates include black spruce and northern white-cedar.)

Oak-hickory.—Forests in which northern red oak, white oak, bur oak, or hickories, singly or in combination, comprise a plurality of the stocking. (Common associates include jack pine, elm, and maple.)

Elm-ash-soft maple.—Forests in which lowland elm, ash, red maple, silver maple, and cottonwood, singly or in combination, comprise a plurality of the stocking. (Common associates include birches, spruce, and balsam fir.)

Maple-basswood.—Forests in which sugar maple, basswood, yellow birch, upland American elm, and red maple, singly or in combination, comprise a plurality of the stocking. (Common associates include white pine and elm.)

Aspen.—Forests in which quaking aspen or bigtooth aspen, singly or in combination, comprise a plurality of the stocking. (Common associates include balsam poplar, balsam fir, and paper birch.)

Paper birch.—Forests in which paper birch comprises a plurality of the stocking. (Common associates include maple, aspen, and balsam fir.)

Growing-stock tree.—A live tree of commercial species that meets specified standards of size, quality, and merchantability. (Note: Excludes rough, rotten, and dead trees.)

Growing-stock volume.—Net volume in cubic feet of growing-stock trees 5.0 inches d.b.h. and over, from 1 foot above the ground to a minimum 4.0-inch top diameter outside bark of the central stem or to the point where the central stem breaks into limbs.

Hard hardwoods.—Hardwood species with an average specific gravity greater than 0.50 such as oaks, hard maple, hickories, and ash.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous. (See Soft hardwoods and Hard hardwoods.)

Land.— A. *Bureau of the Census.* Dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than one-eighth of a statute mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

B. *Forest Inventory and Analysis.* The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

Log grade.—A log classification based on external characteristics as indicators of quality or value. (See Appendix for specific grading factors used.)

Merchantable.—Refers to a pulpwood or saw-log section that meets pulpwood or saw-log specifications, respectively.

Mortality.—The volume of sound wood in growing-stock and sawtimber trees that die annually.

National Forest land.—Federal land that has been legally designated as National Forest or purchase units, and other land administered by the USDA Forest Service.

Net annual growth of growing stock.— The annual change in volume of sound wood in live sawtimber and poletimber trees and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes.

Net annual growth of sawtimber.—The annual change in the volume of live sawtimber trees and the total volume of trees reaching sawtimber size, less volume losses resulting from natural causes.

Net volume.—Gross volume less deductions for rot, sweep, or other defect affecting use for timber products.

Noncommercial species.—Tree species of typically small size, poor form, or inferior quality that normally do not develop into trees suitable for industrial wood products.

Nonforest land.—Land that has never supported forests, and land formerly forested where use for timber management is precluded by development for other uses. (Note: Includes areas used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet wide and more than 1 acre in area to qualify as nonforest land.)

a. Nonforest land without trees.— Nonforest land with no live trees present.

b. Nonforest land with trees.—Nonforest land with one or more trees per acre at least 5 inches d.b.h.

Nonstocked land.—Forest land less than 16.7 percent stocked with all live trees.

Other forest land.—Forest land not capable of producing 20 cubic feet per acre per year of industrial wood crops under natural conditions and not associated with urban or rural development. These sites often contain tree species that are not currently utilized for industrial wood production or trees of poor form, small size, or inferior quality that are unfit for industrial products. Unproductivity may be the result of adverse site conditions such as sterile soil, dry climate, poor drainage, high elevation, and rockiness. This land is not withdrawn from timber utilization.

Other removals.—Growing-stock trees removed but not utilized for products, or trees left standing but "removed" from the timberland classification by land use change. Examples are removals from cultural operations such as timber stand improvement work, land clearing, and changes in land use.

Poletimber stand.—(See Stand-size class.)

Poletimber tree.—A growing-stock tree of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size.

Reserved forest land.—Forest land withdrawn from timber utilization through statute, administrative regulation, designation, or exclusive use for Christmas tree production, as indicated by annual shearing.

Rotten tree.—A tree that does not meet regional merchantability standards because of excessive unsound cull. May include noncommercial tree species.

Rough tree.—A tree that does not meet regional merchantability standards because of excessive sound cull. May include noncommercial tree species.

Salvable dead tree.—A standing or down dead tree considered merchantable by regional standards.

Sapling.—A live tree 1.0 to 5.0 inches d.b.h.

Sapling-seedling stand.—(See Stand-size class.)

Saw log.—A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight and with a minimum diameter outside bark (d.o.b.) for softwoods of 7.0 inches (9.0 inches for hardwoods) or other combinations of size and defect specified by regional standards.

Saw-log portion.—That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top.—The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0 inches d.o.b. for softwoods and 9.0 inches d.o.b. for hardwoods.

Sawtimber stand.—(See Stand-size class.)

Sawtimber tree.—A growing-stock tree of commercial species containing at least a 12-foot saw log or two noncontiguous saw logs 8 feet or longer, and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches d.b.h.

Sawtimber volume.—Net volume of the saw-log portion of live sawtimber in board feet, International 1/4-inch rule (unless specified otherwise) from stump to a minimum 7 inches top diameter outside bark (d.o.b.) for softwoods and a minimum 9 inches top d.o.b. for hardwoods.

Seedling.—A live tree less than 1.0 inch d.b.h. that is expected to survive. Only softwood seedlings more than 6 inches tall and hardwood seedlings more than 1 foot tall are counted.

Short-log (rough tree).—Sawtimber-size trees of commercial species that contain at least one merchantable 8- to 11-foot saw log but not a 12-foot saw log.

Site class.—A classification of forest lands in terms of inherent capacity to grow crops of industrial wood. The class identifies the potential growth in merchantable cubic feet/acre/year at culmination of mean annual increment of fully stocked natural stands.

Site index.—An expression of forest site quality based on the height of a free-growing dominant or codominant tree of a representative species in the forest type at age 50.

Soft hardwoods.—Hardwood species with an average specific gravity less than 0.50 such as gum, yellow-poplar, cottonwood, red maple, basswood, and willow.

Softwoods.—Coniferous trees, usually evergreen, having needles or scale-like leaves.

Stand.—A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

Stand-size class.—A classification of stocked (see Stocking) forest land based on the size class of live trees on the area; that is, sawtimber, poletimber, or seedlings and saplings.

a. Sawtimber stands.—Stands with half or more of live stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

b. Poletimber stands.—Stands with half or more live stocking in poletimber and/or sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

c. Sapling-seedling stands.—Stands with more than half of the live stocking in saplings and/or seedlings.

State land.—Land owned by States or leased to them for 50 years or more.

Stocking.—The degree of occupancy of land by live trees, measured by basal area and/or the number of trees in a stand by size or age and spacing, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

A stocking percent of 100 indicates full utilization of the site and is equivalent to 80 square feet of basal area per acre in trees 5.0 inches d.b.h. and larger. In a stand of trees less than 5 inches d.b.h., a stocking percent of 100 would indicate that the present number of trees is sufficient to produce 80 square feet of basal area per acre when the trees reach 5 inches d.b.h.

Stands are grouped into the following stocking classes:

Overstocked stands.—Stands in which stocking of live trees is 133 percent or more.

Fully stocked stands.—Stands in which stocking of live trees is from 100.0 to 132.9 percent.

Med*ium stocked stands.*—Stands in which stocking of live trees is from 60.0 to 99.9 percent.

Poorly stocked stands.—Stands in which stocking of live trees is from 16.7 to 59.9 percent.

Nonstocked areas.—Timberland on which stocking of live trees is less than 16.7 percent.

Timberland.—Forest land that is producing or capable of producing in excess of 20 cubic feet per acre per year of industrial wood crops under natural conditions, that is not withdrawn from timber utilization, and that is not associated with urban or rural development. Currently inaccessible and inoperable areas are included (formerly commercial forestland).

Tree.—A woody plant usually having one or more perennial stems, a more or less definitely formed crown of foliage, and a height of at least 12 feet at maturity.

Tree size class.—A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Upper stem portion.—That part of the bole of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches outside bark or to the point where the central stem breaks into limbs.

Water.—(a) *Bureau of the Census.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds at least 40 acres in area; and streams, sloughs, estuaries, and canals at least one-eighth of a statute mile wide.

(b) *Noncensus.*—Permanent inland water surfaces, such as lakes, reservoirs, and ponds from 1 to 39.9 acres in area; and streams, sloughs, estuaries, and canals from 120 feet to one-eighth of a statute mile wide.

Wooded strip.—An acre or more of natural continuous forest land that would otherwise meet survey standards for timberland except that it is less than 120 feet wide.

TABLES

Table 1.—Area of land by county and major land-use class, Superior National Forest, 1990

Table 2.—Area of land by district and major land-use class, Superior National Forest, 1990

Table 3.—Area of timberland by forest type and stand-size class, Superior National Forest, 1990

Table 4.—Area of timberland by forest type and potential productivity class, Superior National Forest, 1990

Table 5.—Area of timberland by forest type and stocking class of growing-stock trees, Superior National Forest, 1990

Table 6.—Number of all live trees on timberland by species group and diameter class, Superior National Forest, 1990

Table 7.—Number of growing-stock trees on timberland by species group and diameter class, Superior National Forest, 1990

Table 8.—Net volume of growing-stock trees on timberland by species group and diameter class, Superior National Forest, 1990

Table 9.—Net volume of sawtimber trees on timberland by species group and diameter class, Superior National Forest, 1990

Table 10.—Net volume of growing stock and sawtimber on timberland by county and species group, Superior National Forest, 1990

Table 11.—Net volume of timber on timberland by class of timber and species group, Superior National Forest, 1990

Table 12.—Net volume of sawtimber trees on timberland by species group and butt log grade, Superior National Forest, 1990

Table 13.—Average net annual growth, mortality, and removals of growing stock and sawtimber on timberland by species group, Superior National Forest, 1980-1990

Table 1.--Area of land by county and major land-use class, Superior National Forest, 1990

(In thousand acres)

County	Land area	Forest land				
		All forest land	Timber-land	Timberland as a percent of land area	Other forest land	Reserved forest land
Cook	619.5	619.5	362.8	58.6	--	256.7
Lake	756.9	688.0	384.6	50.8	4.5	298.9
St.Louis	772.6	736.3	506.5	65.6	13.2	216.6
All counties	2,149.0	2,043.8	1,253.9	58.3	17.7	772.2

Table 2.--Area of land by district and major land-use class, Superior National Forest, 1990

(In thousand acres)

National Forest District	Land area	Forest land				
		All forest land	Timber-land	Timberland as a percent of land area	Other forest land	Reserved forest land
Gunflint	387.5	380.7	211.1	54.5	--	169.6
Kawishiwi	430.3	403.1	171.5	39.9	4.3	227.3
La Croix	435.7	407.4	224.9	51.6	1.5	181.0
Laurentian	329.2	324.0	315.3	95.8	8.7	--
Tofte	566.3	528.6	331.1	58.5	3.2	194.3
All districts	2,149.0	2,043.8	1,253.9	58.3	17.7	772.2

Table 3.--Area of timberland by forest type and stand-size class, Superior National Forest, 1990

(In thousand acres)

Forest type	All stands	Stand-size class			
		Sawtimber	Poletimber	Seedling & sapling	Nonstocked
Jack pine	63.7	32.7	17.9	13.1	--
Red pine	60.6	35.3	15.4	9.9	--
White pine	11.3	9.4	--	1.9	--
Balsam fir	168.0	39.2	76.8	52.0	--
White spruce	24.8	6.5	10.3	8.0	--
Black spruce	211.3	17.0	93.8	100.5	--
Northern white-cedar	66.0	44.0	15.2	6.8	--
Tamarack	9.7	3.0	2.9	3.8	--
Oak-hickory	2.8	--	--	2.8	--
Elm-ash-soft maple	25.3	8.0	7.3	10.0	--
Maple-basswood	55.1	33.3	7.6	14.2	--
Aspen	408.4	124.3	137.0	147.1	--
Paper birch	132.8	25.8	76.7	30.3	--
Balsam poplar	5.3	3.8	--	1.5	--
Nonstocked	8.8	--	--	--	8.8
All types	1,253.9	382.3	460.9	4,01.9	8.8

Table 4.--Area of timberland by forest type and potential productivity class, Superior National Forest, 1990

(In thousand acres)

Forest type	All classes	Potential productivity class (cu.ft. of growth per acre per year) 165+	120-164	85-119	50-84	20-49
Jack pine	63.7	--	--	5.5	31.8	26.4
Red pine	60.6	--	3.0	34.1	22.0	1.5
White pine	11.3	--	--	1.4	6.1	3.8
Balsam fir	168.0	--	--	--	--	168.0
White spruce	24.8	--	--	--	--	24.8
Black spruce	211.3	--	--	--	--	211.3
Northern white-cedar	66.0	--	--	--	--	66.0
Tamarack	9.7	--	--	--	--	9.7
Oak-hickory	2.8	--	--	--	--	2.8
Elm-ash-soft maple	25.3	--	--	--	--	25.3
Maple-basswood	55.1	--	--	--	2.4	52.7
Aspen	408.4	--	--	79.5	248.6	80.3
Paper birch	132.8	--	--	--	--	132.8
Balsam poplar	5.3	--	--	--	--	5.3
Nonstocked	8.8	--	--	--	--	8.8
All types	1,253.9	--	3.0	120.5	310.9	819.5

Table 5.--Area of timberland by forest type and stocking class of growing-stock trees[1], Superior National Forest, 1990

(In thousand acres)

Forest type	All classes	Stocking percent of growing-stock trees Non-stocked	Poorly stocked	Moderately stocked	Fully stocked	Over-stocked
Jack pine	63.7	--	5.2	24.7	26.2	7.6
Red pine	60.6	--	5.5	15.2	26.2	13.7
White pine	11.3	--	--	--	5.5	5.8
Balsam fir	168.0	--	12.8	46.1	77.5	31.6
White spruce	24.8	--	3.1	8.9	12.8	--
Black spruce	211.3	--	9.8	73.7	76.3	51.5
Northern white-cedar	66.0	2.6	1.5	21.0	28.3	12.6
Tamarack	9.7	--	2.1	3.1	2.4	2.1
Oak-hickory	2.8	1.5	--	--	1.3	--
Elm-ash-soft maple	25.3	--	8.8	6.8	9.7	--
Maple-basswood	55.1	0.9	4.7	16.0	28.1	5.4
Aspen	408.4	--	26.7	118.7	177.2	85.8
Paper birch	132.8	--	13.4	46.7	42.4	30.3
Balsam poplar	5.3	--	--	4.0	1.3	--
Nonstocked	8.8	8.8	--	--	--	--
All types	1,253.9	13.8	93.6	384.9	515.2	246.4

[1] This table is based on the stocking percent of growing-stock trees rather than that of all live trees. To use the definitions of stocking for this table, replace the term "all live" by "growing-stock."

Table 6.--Number of all live trees on timberland by species group and diameter class, Superior National Forest, 1990

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height) 1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Jack pine	27,609	7,869	6,782	5,510	3,425	2,232	1,099	492	150	42	5	3	--
Red pine	13,377	2,574	3,204	2,372	1,889	1,449	915	419	261	200	61	33	--
White pine	3,878	816	666	534	388	423	287	205	145	116	119	134	45
White spruce	20,353	7,623	4,404	3,613	2,305	1,086	635	308	201	120	42	16	--
Black spruce	138,633	59,484	41,742	25,121	9,557	2,183	412	91	37	6	--	--	--
Balsam fir	159,798	90,035	37,289	19,703	8,689	3,081	827	138	33	3	--	--	--
Tamarack	11,145	5,604	2,601	1,655	797	263	168	22	35	--	--	--	--
Northern white-cedar	21,109	6,624	3,129	2,998	2,790	2,634	1,404	892	368	152	65	53	--
Total	395,902	180,629	99,817	61,506	29,840	13,351	5,747	2,567	1,230	639	292	239	45
Hardwoods													
Select red oak	2,716	1,587	708	295	60	53	--	10	--	3	--	--	--
Other red oak	110	39	57	--	14	--	--	--	--	--	--	--	--
Basswood	9	--	--	--	--	9	--	--	--	--	--	--	--
Yellow birch	1,533	711	150	232	110	47	73	79	46	29	29	21	6
Hard maple	15,932	8,103	3,246	2,096	1,226	536	290	158	88	92	46	50	1
Soft maple	38,546	22,780	8,458	4,686	1,657	642	156	106	36	20	2	3	--
Elm	305	204	63	38	--	--	--	--	--	--	--	--	--
Black ash	11,824	6,816	2,496	1,395	541	354	132	52	23	8	3	4	--
White and green ash	455	303	51	64	--	17	20	--	--	--	--	--	--
Cottonwood	11	--	--	--	--	11	--	--	--	--	--	--	--
Willow	117	48	--	49	20	--	--	--	--	--	--	--	--
Balsam poplar	5,481	2,157	759	617	765	587	331	165	65	24	5	6	--
Bigtooth aspen	5,173	2,655	510	624	618	459	139	92	49	25	2	--	--
Quaking aspen	143,159	85,332	17,922	12,968	9,622	8,174	4,714	2,516	1,230	434	123	124	--
Paper birch	97,941	38,364	24,735	17,998	9,245	4,659	1,816	628	284	139	43	28	2
Black cherry	777	549	228	--	--	--	--	--	--	--	--	--	--
Other hardwoods	8	--	--	--	--	--	8	--	--	--	--	--	--
Noncommercial sp.	44,103	42,858	1,095	57	72	3	8	10	--	--	--	--	--
Total	368,200	212,506	60,478	41,119	23,950	15,551	7,687	3,816	1,821	774	253	236	9
All species	764,102	393,135	160,295	102,625	53,790	28,902	13,434	6,383	3,051	1,413	545	475	54

Table 7.--Number of growing-stock trees on timberland by species group and diameter class, Superior National Forest, 1990

(In thousand trees)

Species group	All classes	Diameter class (inches at breast height) 1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods													
Jack pine	27,257	7,869	6,582	5,479	3,379	2,202	1,084	482	142	32	3	3	--
Red pine	13,317	2,574	3,204	2,372	1,865	1,433	895	419	261	200	61	33	--
White pine	3,833	816	666	534	372	417	281	190	143	116	119	134	45
White spruce	20,194	7,584	4,404	3,534	2,290	1,072	628	308	196	120	42	16	--
Black spruce	138,028	59,397	41,556	24,905	9,501	2,141	406	91	25	6	--	--	--
Balsam fir	158,427	89,921	36,671	19,269	8,610	3,029	755	136	33	3	--	--	--
Tamarack	10,962	5,559	2,568	1,627	742	254	155	22	35	--	--	--	--
Northern white-cedar	19,234	6,624	2,937	2,461	2,537	2,262	1,141	767	282	134	55	34	--
Total	391,252	180,344	98,588	60,181	29,296	12,810	5,345	2,415	1,117	611	280	220	45
Hardwoods													
Select red oak	2,528	1,587	594	263	28	53	--	--	--	3	--	--	--
Other red oak	96	39	57	--	--	--	--	--	--	--	--	--	--
Basswood	9	--	--	--	--	9	--	--	--	--	--	--	--
Yellow birch	1,359	711	150	209	92	33	35	61	33	14	13	7	1
Hard maple	15,505	8,103	3,171	2,075	1,134	490	233	125	59	58	29	28	--
Soft maple	36,773	22,711	8,009	4,088	1,346	469	70	64	11	3	2	--	--
Elm	305	204	63	38	--	0	--	--	--	--	--	--	--
Black ash	11,614	6,816	2,400	1,345	519	354	105	47	15	8	3	2	--
White and green ash	449	303	51	64	--	17	14	--	--	--	--	--	--
Cottonwood	11	--	--	--	--	11	--	--	--	--	--	--	--
Willow	48	48	--	--	--	--	--	--	--	--	--	--	--
Balsam poplar	5,442	2,157	759	617	765	580	318	160	54	24	2	6	--
Bigtooth aspen	5,129	2,655	510	624	618	459	132	67	40	22	2	--	--
Quaking aspen	140,719	85,233	17,736	12,505	9,303	7,733	4,335	2,218	1,112	352	104	88	--
Paper birch	94,847	38,073	24,030	17,494	8,532	4,240	1,628	518	198	97	19	16	2
Black cherry	708	480	228	--	--	--	--	--	--	--	--	--	--
Other hardwoods	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	315,542	169,120	57,758	39,322	22,337	14,448	6,870	3,260	1,522	581	174	147	3
All species	706,794	349,464	156,346	99,503	51,633	27,258	12,215	5,675	2,639	1,192	454	367	48

Table 8.--Net volume of growing-stock trees on timberland by species group and diameter class, Superior National Forest, 1990

(In thousand cubic feet)

Species group	All classes	Diameter class (inches at breast height) 5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods											
Jack pine	86,731	13,031	17,582	21,463	16,918	11,258	4,701	1,416	152	210	--
Red pine	77,947	6,158	10,328	13,796	14,546	9,875	8,526	8,648	3,489	2,581	--
White pine	54,129	1,179	1,912	3,835	4,497	4,274	4,846	5,090	6,823	13,257	8,416
White spruce	69,670	8,927	13,686	11,741	11,083	7,901	7,014	5,511	2,494	1,313	--
Black spruce	158,091	68,936	56,172	22,586	7,006	2,181	944	266	--	--	--
Balsam fir	142,116	47,828	48,214	30,128	11,812	3,036	995	103	--	--	--
Tamarack	16,645	4,793	4,531	2,955	2,656	547	1,163	--	--	--	--
Northern white-cedar	83,071	5,713	12,283	19,315	14,924	14,541	7,312	4,599	2,412	1,972	--
Total	688,400	156,565	164,708	125,819	83,442	53,613	35,501	25,633	15,370	19,333	8,416
Hardwoods											
Select red oak	1,240	565	133	451	--	--	--	91	--	--	--
Other red oak	--	--	--	--	--	--	--	--	--	--	--
Basswood	82	--	--	82	--	--	--	--	--	--	--
Yellow birch	5,381	496	497	377	527	1,186	810	458	495	460	75
Hard maple	31,014	5,457	6,525	4,819	3,794	2,922	1,944	2,182	1,376	1,995	--
Soft maple	24,987	9,825	7,637	4,447	1,117	1,359	398	91	113	--	--
Elm	109	109	--	--	--	--	--	--	--	--	--
Black ash	13,311	3,416	2,879	3,434	1,539	1,121	426	282	110	104	--
White and green ash	496	111	--	185	200	--	--	--	--	--	--
Cottonwood	97	--	--	97	--	--	--	--	--	--	--
Willow	--	--	--	--	--	--	--	--	--	--	--
Balsam poplar	24,680	1,531	4,693	6,219	5,286	3,769	1,647	1,037	96	402	--
Bigtooth aspen	17,186	1,786	3,720	5,095	2,243	1,659	1,503	1,054	126	--	--
Quaking aspen	356,171	32,083	54,814	81,260	71,313	53,192	36,382	14,970	5,725	6,432	--
Paper birch	194,919	47,983	51,783	43,840	26,782	11,973	6,117	3,926	965	1,170	380
Black cherry	--	--	--	--	--	--	--	--	--	--	--
Other hardwoods	--	--	--	--	--	--	--	--	--	--	--
Total	669,673	103,362	132,681	150,306	112,801	77,181	49,227	24,091	9,006	10,563	455
All species	1,358,073	259,927	297,389	276,125	196,243	130,794	84,728	49,724	24,376	29,896	8,871

Table 9.--Net volume of sawtimber trees on timberland by species group and diameter class, Superior National Forest, 1990

(In thousand board feet)[1]

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Jack pine	277,955	102,194	83,217	57,613	25,029	7,822	860	1,220	--
Red pine	327,090	69,851	74,997	52,384	46,488	48,360	19,899	15,111	--
White pine	275,985	17,746	21,414	21,037	24,912	27,038	37,219	75,608	51,011
White spruce	253,000	59,777	57,933	42,646	38,988	31,348	14,492	7,816	--
Black spruce	174,481	117,854	37,643	12,053	5,383	1,548	--	--	--
Balsam fir	224,326	144,453	58,440	15,611	5,248	574	--	--	--
Tamarack	37,767	14,753	13,723	2,913	6,378	--	--	--	--
Northern white-cedar	338,237	97,495	75,913	75,735	39,079	25,123	13,509	11,383	--
Total	1,908,841	624,123	423,280	279,992	191,505	141,813	85,979	111,138	51,011
Hardwoods									
Select red oak	439	--	--	--	--	439	--	--	--
Other red oak	--	--	--	--	--	--	--	--	--
Basswood	--	--	--	--	--	--	--	--	--
Yellow birch	19,624	--	2,361	5,573	3,947	2,321	2,557	2,452	413
Hard maple	66,209	--	15,997	13,291	9,213	10,623	6,848	10,237	--
Soft maple	13,488	--	4,608	6,041	1,846	441	552	--	--
Elm	--	--	--	--	--	--	--	--	--
Black ash	16,500	--	6,723	5,223	2,063	1,394	559	538	--
White and green ash	850	--	850	--	--	--	--	--	--
Cottonwood	--	--	--	--	--	--	--	--	--
Willow	--	--	--	--	--	--	--	--	--
Balsam poplar	54,580	--	22,410	16,919	7,770	4,987	475	2,019	--
Bigtooth aspen	30,164	--	9,593	7,637	7,161	5,151	622	--	--
Quaking aspen	856,591	--	305,749	243,258	172,690	73,165	28,642	33,087	--
Paper birch	223,649	--	111,016	53,144	28,331	18,631	4,682	5,852	1,993
Black cherry	--	--	--	--	--	--	--	--	--
Other hardwoods	--	--	--	--	--	--	--	--	--
Total	1,282,094	--	479,307	351,086	233,021	117,152	44,937	54,185	2,406
All species	3,190,935	624,123	902,587	631,078	424,526	258,965	130,916	165,323	53,417

[1] International 1/4-inch rule.

Table 9.--Net volume of sawtimber trees on timberland by species group and diameter class, Superior National Forest, 1990

(In thousand board feet)[1]

Species group	All classes	Diameter class (inches at breast height) 9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+
Softwoods									
Jack pine	277,955	102,194	83,217	57,613	25,029	7,822	860	1,220	--
Red pine	327,090	69,851	74,997	52,384	46,488	48,360	19,899	15,111	--
White pine	275,985	17,746	21,414	21,037	24,912	27,038	37,219	75,608	51,011
White spruce	253,000	59,777	57,933	42,646	38,988	31,348	14,492	7,816	--
Black spruce	174,481	117,854	37,643	12,053	5,383	1,548	--	--	--
Balsam fir	224,326	144,453	58,440	15,611	5,248	574	--	--	--
Tamarack	37,767	14,753	13,723	2,913	6,378	--	--	--	--
Northern white-cedar	338,237	97,495	75,913	75,735	39,079	25,123	13,509	11,383	--
Total	1,908,841	624,123	423,280	279,992	191,505	141,813	85,979	111,138	51,011
Hardwoods									
Select red oak	439	--	--	--	--	439	--	--	--
Other red oak	--	--	--	--	--	--	--	--	--
Basswood	--	--	--	--	--	--	--	--	--
Yellow birch	19,624	--	2,361	5,573	3,947	2,321	2,557	2,452	413
Hard maple	66,209	--	15,997	13,291	9,213	10,623	6,848	10,237	--
Soft maple	13,488	--	4,608	6,041	1,846	441	552	--	--
Elm	--	--	--	--	--	--	--	--	--
Black ash	16,500	--	6,723	5,223	2,063	1,394	559	538	--
White and green ash	850	--	850	--	--	--	--	--	--
Cottonwood	--	--	--	--	--	--	--	--	--
Willow	--	--	--	--	--	--	--	--	--
Balsam poplar	54,580	--	22,410	16,919	7,770	4,987	475	2,019	--
Bigtooth aspen	30,164	--	9,593	7,637	7,161	5,151	622	--	--
Quaking aspen	856,591	--	305,749	243,258	172,690	73,165	28,642	33,087	--
Paper birch	223,649	--	111,016	53,144	28,331	18,631	4,682	5,852	1,993
Black cherry	--	--	--	--	--	--	--	--	--
Other hardwoods	--	--	--	--	--	--	--	--	--
Total	1,282,094	--	479,307	351,086	233,021	117,152	44,937	54,185	2,406
All species	3,190,935	624,123	902,587	631,078	424,526	258,965	130,916	165,323	53,417

[1] International 1/4-inch rule.

Table 10.--Net volume of growing stock and sawtimber on timberland by county and species group, Superior National Forest, 1990

County	All species	Species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
	Thousand cubic feet of growing stock				
Cook	457,542	33,503	189,717	199,602	34,720
Lake	363,004	75,481	132,743	148,125	6,655
St. Louis	537,527	109,823	147,133	270,504	10,067
All counties	1,358,073	218,807	469,593	618,231	51,442
	Thousand board feet [1] of sawtimber				
Cook	1,097,489	135,044	496,859	384,828	80,758
Lake	806,540	267,683	275,413	247,840	15,604
St. Louis	1,286,906	478,303	255,539	545,804	7,260
All counties	3,190,935	881,030	1,027,811	1,178,472	103,622

[1] International 1/4-inch rule.

Table 11.--Net volume of timber on timberland by class of timber and species group, Superior National Forest, 1990

(In thousand cubic feet)

Class of timber	All species	Species group			
		Pine	Other softwoods	Soft hardwoods	Hard hardwoods
Live trees					
Growing-stock trees					
Sawtimber					
Saw-log portion	527,605	148,675	173,811	188,759	16,360
Upper stem portion	122,846	19,942	24,699	72,468	5,737
Total	650,451	168,617	198,510	261,227	22,097
Poletimber	707,622	50,190	271,083	357,004	29,345
All growing-stock trees	1,358,073	218,807	469,593	618,231	51,442
Cull trees					
Short-log trees	13,508	843	3,355	6,579	2,731
Rough trees					
Sawtimber	8,374	642	2,088	4,312	1,332
Poletimber	13,324	308	3,050	8,730	1,236
Total	21,698	950	5,138	13,042	2,568
Rotten trees					
Sawtimber	19,055	310	4,094	11,504	3,147
Poletimber	6,395	88	808	5,063	436
Total	25,450	398	4,902	16,567	3,583
All cull trees	60,656	2,191	13,395	36,188	8,882
All live trees	1,418,729	220,998	482,988	654,419	60,324
Salvable dead trees					
Sawtimber	4,084	877	1,902	1,281	24
Poletimber	3,134	122	1,904	1,108	--
Total	7,218	999	3,806	2,389	24
All classes of timber	1,425,947	221,997	486,794	656,808	60,348

Table 12.--Net volume of sawtimber trees on timberland by species group and butt log grade, Superior National Forest, 1990

(In thousand board feet)[1]

Species group	All grades	Butt log grade			
		1	2	3	Tie and timber
Softwoods					
Jack pine	277,955	--	20,046	257,909	--
Red pine	327,090	37,885	38,829	250,376	--
White pine	275,985	69,243	61,097	131,901	13,743
White spruce	253,000	7,010	24,958	221,032	--
Black spruce	174,481	--	3,076	171,405	--
Balsam fir	224,326	--	1,743	222,583	--
Tamarack	37,767	--	2,549	35,218	--
Northern white-cedar	338,237	2,417	13,077	322,742	--
Total	1,908,841	116,557	165,374	1,613,167	13,743
Hardwoods					
Select red oak	439	36	161	220	21
Other red oak	--	--	--	--	--
Basswood	--	--	--	--	--
Yellow birch	19,624	5,427	3,748	9,672	777
Hard maple	66,209	5,491	24,307	33,229	3,182
Soft maple	13,488	3,794	--	8,825	869
Elm	--	--	--	--	--
Black ash	16,500	--	2,514	13,986	--
White and green ash	850	--	129	721	--
Cottonwood	--	--	--	--	--
Willow	--	--	--	--	--
Balsam poplar	54,580	3,536	8,978	42,066	--
Bigtooth aspen	30,164	958	16,677	12,529	--
Quaking aspen	856,591	69,691	168,245	596,843	21,813
Paper birch	223,649	20,027	44,563	153,373	5,686
Black cherry	--	--	--	--	--
Other hardwoods	--	--	--	--	--
Total	1,282,094	108,960	269,322	871,464	32,348
All species	3,190,935	225,516	434,697	2,484,630	46,092

[1] International 1/4-inch rule.

Table 13.--Average net annual growth, mortality, and removals of growing stock and sawtimber on timberland by species group, Superior National Forest, 1980-1990

Species group	Growing stock			Sawtimber		
	Net growth[1]	Mortality	Removals	Net growth[1]	Mortality	Removals
	Thousand cubic feet			*Thousand board feet*[2]		
Softwoods						
Jack pine	1,200	1,828	498	4,500	6,793	1,909
Red pine	3,401	3	1,961	14,475	7	8,608
White pine	1,779	135	2,058	9,878	803	9,956
White spruce	3,681	495	956	13,073	2,345	4,429
Black spruce	1,797	3,004	2,748	7,399	4,012	2,336
Balsam fir	2,002	5,005	1,217	10,492	8,427	1,063
Tamarack	485	129	--	1,454	338	--
Northern white-cedar	1,317	193	--	7,434	1,174	--
Total	15,662	10,792	9,438	68,705	23,899	28,301
Hardwoods						
Select red oak	88	21	--	13	1	--
Other red oak	--	--	--	--	--	--
Basswood	2	--	--	--	--	--
Yellow birch	80	56	--	550	207	--
Hard maple	856	73	--	1,884	353	--
Soft maple	1,191	300	66	838	115	--
Elm	-27	28	--	--	--	--
Black ash	311	95	--	429	201	--
White and green ash	23	--	--	177	3	--
Cottonwood	2	1	--	--	--	--
Willow	--	--	--	--	--	--
Balsam poplar	46	691	631	2,102	1,538	1,311
Bigtooth aspen	487	170	61	1,644	322	--
Quaking aspen	8,953	5,711	5,322	39,223	14,141	13,989
Paper birch	3,058	2,386	4,610	7,639	3,321	4,266
Black cherry	21	--	--	--	--	--
Other hardwoods	--	--	--	--	--	--
Total	15,091	9,532	10,690	54,499	20,202	19,566
All species	30,753	20,324	20,128	123,204	44,101	47,867

[1]An estimate of average gross growth may be computed by adding average mortality to average net growth.

[2]International 1/4-inch rule.

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Presents highlights and statistics on area, volume, growth, removals, and mortality from the 1990 forest inventory of the Superior National Forest.

KEY WORDS: Area, volume, growth, removals, mortality.

Our job at the North Central Forest Experiment Station is discovering and creating new knowledge and technology in the field of natural resources and conveying this information to the people who can use it. As a new generation of forests emerges in our region, managers are confronted with two unique challenges: (1) Dealing with the great diversity in composition, quality, and ownership of the forests, and (2) Reconciling the conflicting demands of the people who use them. Helping the forest manager meet these challenges while protecting the environment is what research at North Central is all about.